THE GARDEN

A Physics-First Framework for Investigating Emergent Complexity in Minimal Computational Realities

White Paper v1.1

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Abstract

The Garden is a proposed computational research framework intended to investigate whether persistent adaptive complexity can emerge from minimal physical rules without predefined goals, agents, or behavioral prescriptions.

Most contemporary artificial intelligence systems achieve performance through explicit objectives, training data, and optimization processes. While successful, these systems embed assumptions regarding desired outcomes. The Garden explores an alternative question:

Can increasingly sophisticated behavior arise naturally from interactions within a constrained but sufficiently rich reality?

The framework does not seek to directly construct intelligence. Instead, it establishes a computational substrate composed of local interactions, energy flow, persistence, and physical representation of information. Intelligence, if it appears, is treated as a consequence rather than a target.

The purpose of this document is not to claim the discovery of a new theory of intelligence. It is to present a research direction, define its assumptions, establish implementation principles, identify risks and limitations, and propose a testable path toward exploration.

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1. Executive Summary

The Garden is a bounded computational reality designed to cultivate emergence rather than construct predetermined outcomes.

The project does not attempt to create:

• a language model
• a civilization simulator
• a human replication system
• a goal-optimized intelligence engine
• a predefined artificial lifeform

Instead, the project establishes:

• a minimal reality substrate
• physically constrained interactions
• embodied information
• persistent history
• continuous energy flow
• observable consequences

The central objective is:

To determine whether unexpected and persistent complexity can arise from simple interacting rules under constrained conditions.

The Garden assumes that meaningful phenomena may initially appear insignificant or incomprehensible and therefore should not be dismissed prematurely.

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2. Research Motivation

Artificial intelligence systems frequently rely on predefined targets:

• optimize an objective
• maximize a reward signal
• imitate a dataset
• achieve a specified task

Biological systems appear to emerge differently.

Natural complexity develops through:

• local interactions
• resource constraints
• persistence under pressure
• accumulated historical effects
• energy flow through open systems

Intelligence was not explicitly specified within natural systems.

It emerged, if at all, as a consequence of deeper processes.

The Garden explores whether computational systems can investigate similar conditions.

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3. Research Questions

Primary Question

Can persistent adaptive complexity emerge from minimal physical interactions without predefined goals?

Secondary Questions

- What minimum conditions support persistent organization?
- Can information arise through physical configuration alone?
- Can adaptation emerge without explicit optimization?
- Can structures embody memory through state rather than metadata?
- Under what conditions does persistent novelty appear?

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4. Foundational Assumptions

The framework assumes the following propositions:

Assumption 1
Simple local interactions can generate persistent complexity.

Assumption 2
Persistent structures can accumulate information.

Assumption 3
Information can influence future interactions.

Assumption 4
Adaptive behavior can emerge from accumulated information.

Assumption 5
Cognition-like phenomena may emerge from sufficiently adaptive systems.

These assumptions remain hypotheses rather than established truths.

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5. Core Principles

Principle 1 — Interactions over Behaviors

The system specifies interactions rather than actions.

Avoid:

"If entity is hungry, eat."

Prefer:

Properties interact and consequences emerge.

Principle 2 — Information is Physical

Information cannot exist independently of representation.

Information must occupy:

• space
• state
• structure

No external memory variables should influence behavior.

Principle 3 — History Matters

Past states alter future possibilities.

The system maintains continuity rather than isolated snapshots.

Principle 4 — Preserve Uncertainty

Unexpected phenomena should not be discarded immediately.

Ambiguous observations remain archived until further evidence appears.

Principle 5 — Minimize Creator Influence

The creator establishes initial conditions but does not direct outcomes.

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6. Proposed Reality Substrate

The Garden proposes a minimal computational reality composed of:

Space
Continuous two-dimensional space.

Time
Discrete timesteps.

Physical Properties

• position
• velocity
• mass
• charge
• energy
• bond states

Interactions

• force interactions
• collisions
• energy transfer
• bond formation
• bond disruption

The substrate defines interactions only.

The substrate does not prescribe purpose.

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7. Primitive Matter

Primitive units possess relational properties rather than behavioral instructions.

Potential properties include:

• mass
• charge
• geometry
• bonding constraints
• energetic state

Atoms do not contain goals or behaviors.

Behavior emerges from interaction.

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8. Information and Memory

The framework assumes that information must be physically embodied.

Potential information mechanisms include:

• structural geometry
• conformational arrangements
• persistent configurations
• state-dependent interactions

Information should not rely upon hidden variables or external tracking systems.

The objective is for history to become physically encoded within structures themselves.

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9. Expected Emergence Cascade

The following stages represent possible observations rather than required outcomes.

Stage 0 — Persistent structures

Stage 1 — Self-maintaining structures

Stage 2 — Information-bearing structures

Stage 3 — Adaptive structures

Stage 4 — Proto-life behavior

Stage 5 — Learning-like behavior

Stage 6 — Candidate cognition

The sequence is hypothetical.

Alternative pathways may exist.

No stage is guaranteed.

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10. Methodology

The framework proposes iterative computational experimentation:

Phase A — Construct minimal substrate

Phase B — Run simulations under varied initial conditions

Phase C — Record complete system states

Phase D — Identify persistent structures

Phase E — Compare observations across independent runs

Results should prioritize reproducibility over isolated phenomena.

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11. What Must Be True

For the framework to remain viable:

- persistent complexity must appear
- information must accumulate
- accumulated information must alter future behavior

• adaptation must provide measurable persistence advantages
• complexity must remain computationally feasible

Failure of these assumptions would require revision.

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12. Risks and Pre-Mortem Analysis

Potential risks include:

Computational Infeasibility
Large-scale emergence may require resources beyond practical limits.

False Emergence
Numerical artifacts may be mistaken for genuine phenomena.

Interpretation Bias
Human observers may assign meaning where none exists.

Equilibrium Collapse
Systems may settle into static configurations that prevent further novelty.

Excess Realism
High physical fidelity may make experimentation impossible.

Excess Simplification
Minimal models may remove necessary conditions for emergence.

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13. Ethics and Research Conduct

The Garden is primarily a computational physics and emergence experiment rather than an experiment on conscious entities.

Principles:

• observations should remain transparent
• interventions should be documented
• assumptions should remain explicit
• claims should remain proportional to evidence

If future iterations suggest candidate cognition or subjective processes, ethical review procedures should be introduced.

Closing Statement

The Garden does not ask:

"What intelligence should we build?"

The Garden asks:

"What happens if we construct the smallest honest reality we can and observe it carefully?"

The answer remains unknown.

That uncertainty is the reason for the experiment.